D0 Measurement of the Inclusive Jet Cross Section

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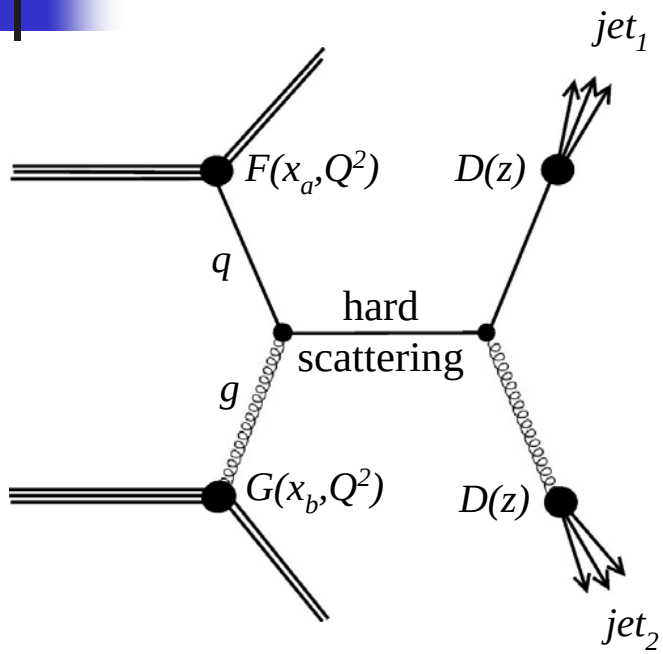
Motivation

Tevatron and D0 Detector

Results

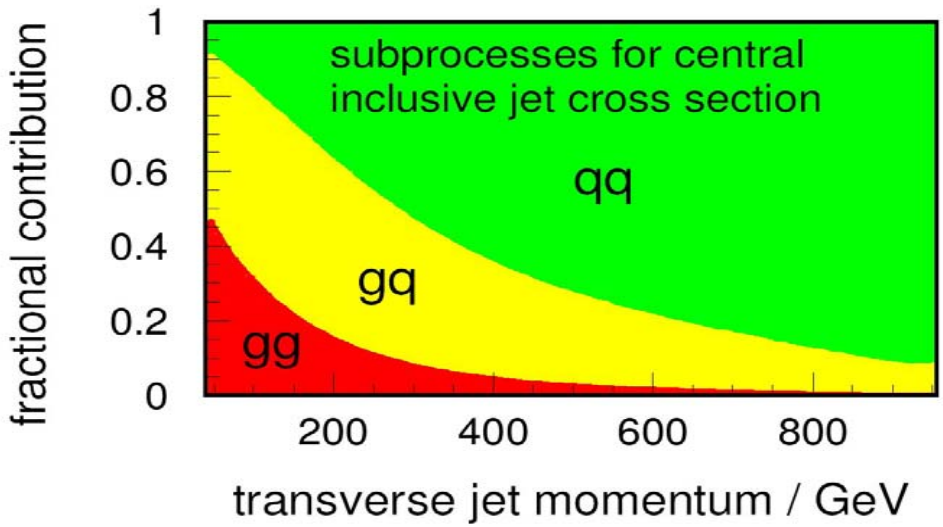
Summary

Motivation



- **Inclusive jets and dijets cross-sections are directly sensitive to the strong coupling constant and parton density functions (PDFs)**

- **Any deviation from the theoretical prediction could be a signal for new physics**

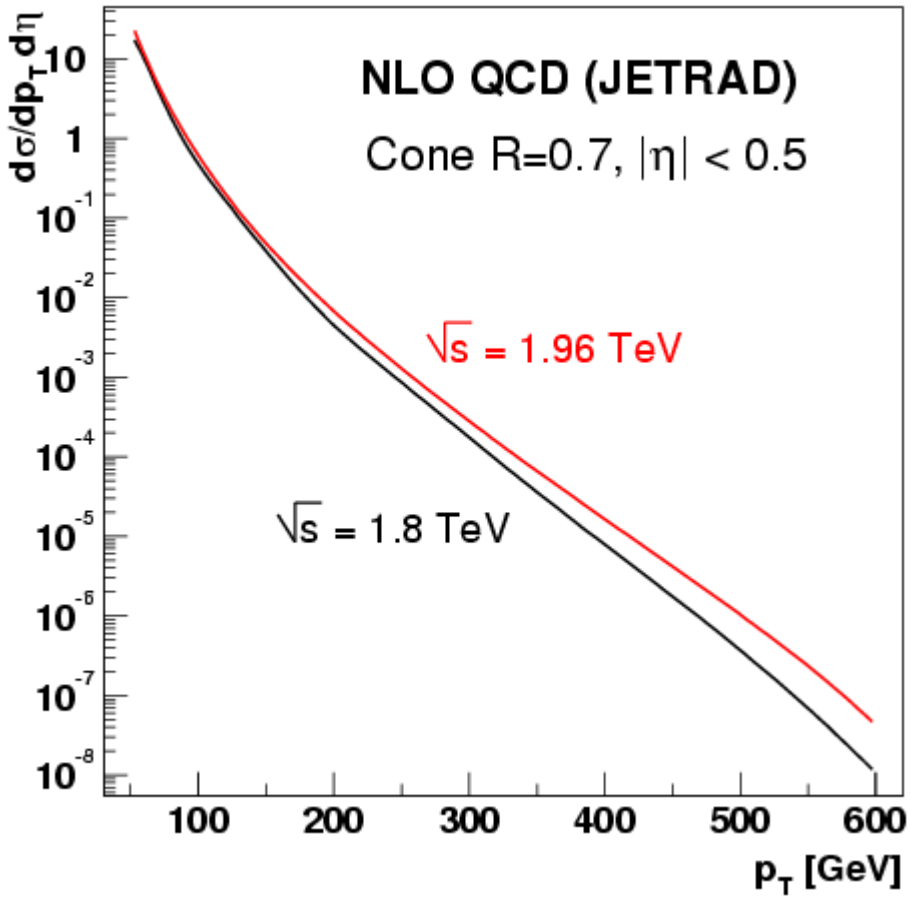


Motivation

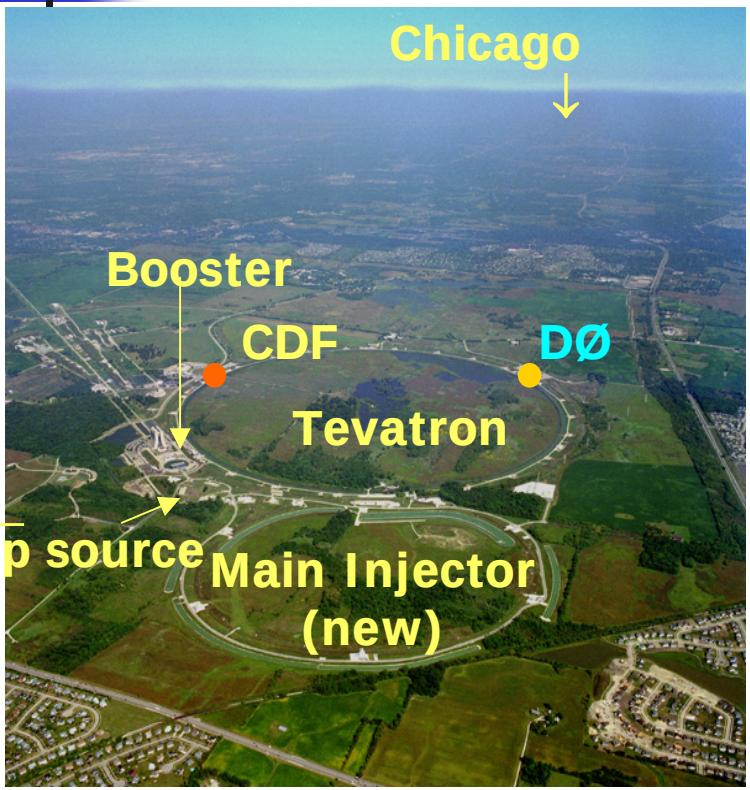
Cross section 2 times larger compared to Run I for jets with p_T > 400 GeV

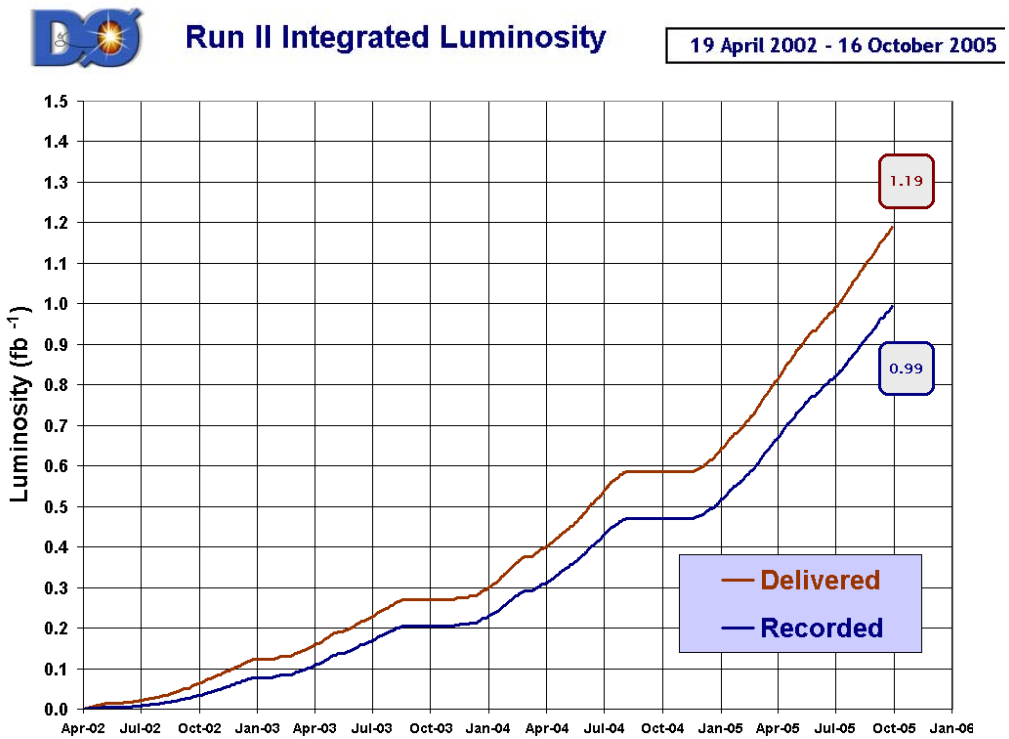
Higher statistics will improve knowledge of proton structure at large x and searches for physics beyond the standard model (e.g. search for compositeness, W', Z' etc...) will be very exciting.

Inclusive jet p_T spectrum



The Run II Tevatron





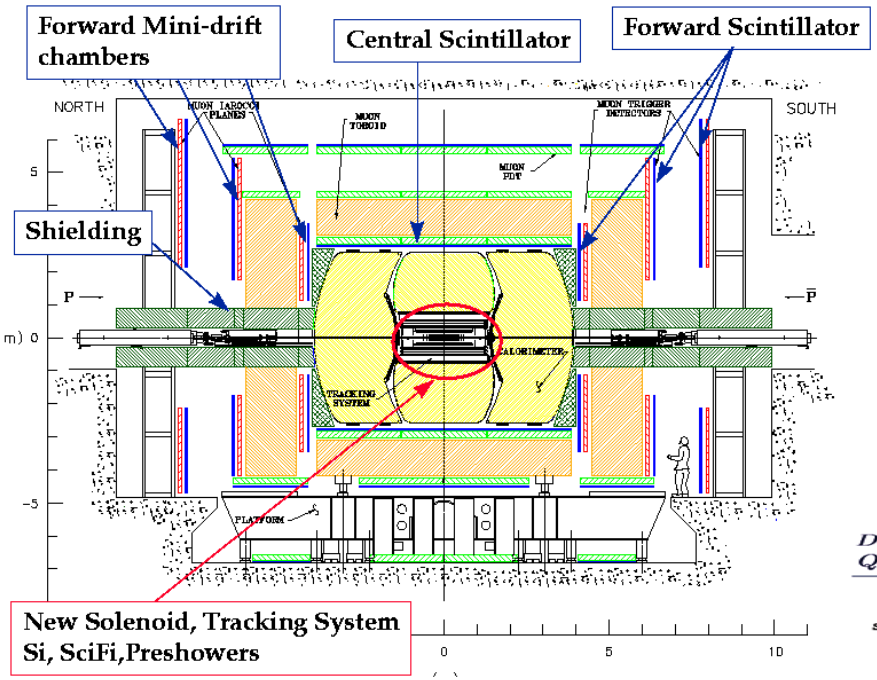
Increased center of mass energy
1.8 TeV → 1.96 TeV

Increased luminosity,
Bunch Crossing time 3.5 μsec -> 396 ns

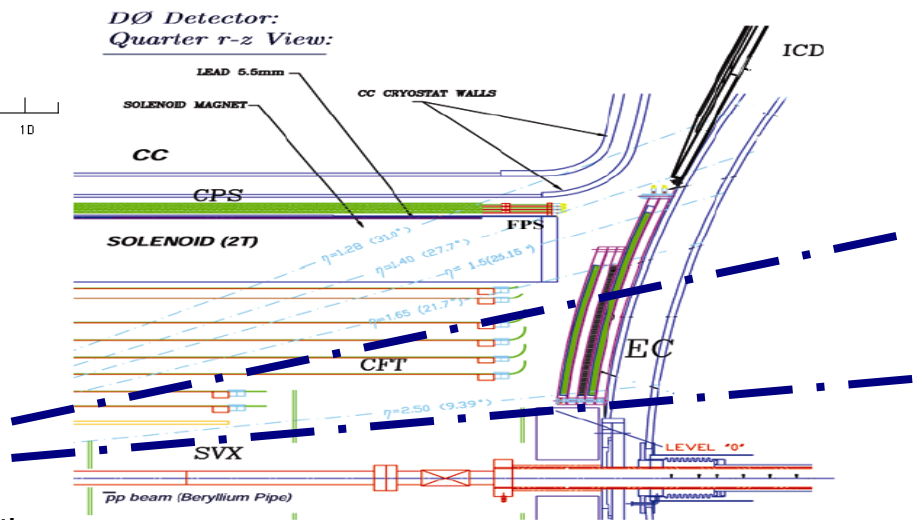
1 fb^{-1} of luminosity recorded so far

378 pb^{-1} luminosity is used for the analysis

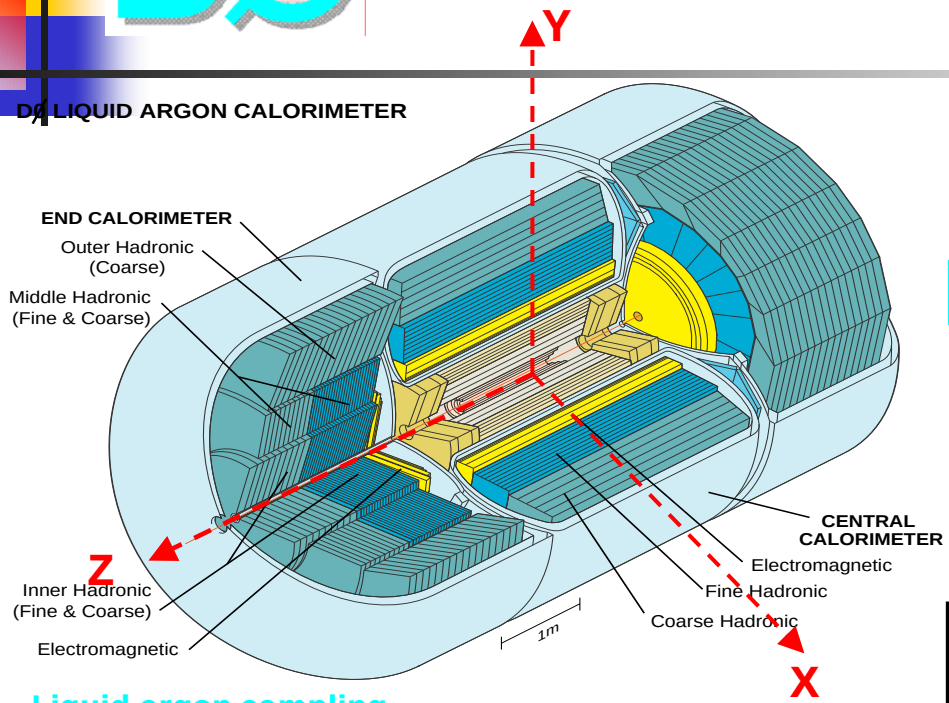
Overview of DØ Detector



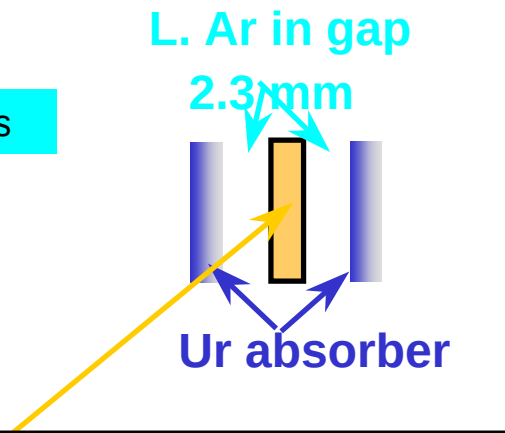
- 2 Tesla solenoid magnetic field for central tracking system to facilitate charge and momentum measurement.
- Silicon and fiber tracker detector.
- Add scintillator detector in muon system for faster trigger
- Pre-shower detectors.
- Pipelined 3 Level trigger



Calorimeter Overview

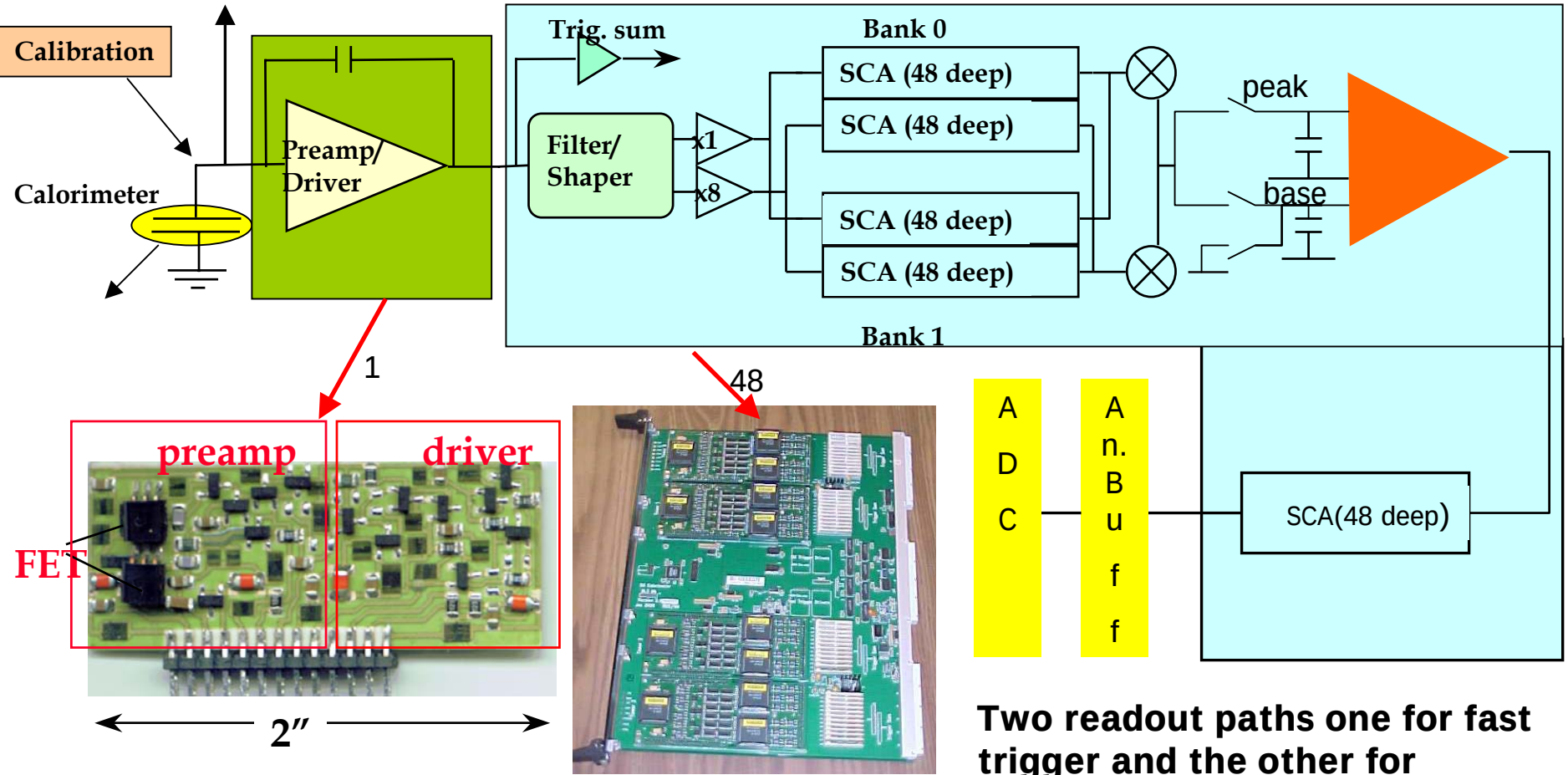


Drift time 430 ns



- Liquid argon sampling
  - Stable, uniform response, rad. hard
  - LAr purity important (impurity <0.5 ppm)
- Uranium absorber (Cu or Steel for coarse hadronic)
- Uniform, hermetic with full coverage
  - $|\eta| < 4.2$ ($\theta \approx 2^o$), $\lambda_{int} > 7.2$ (total)
- Fine Segmentation
  - $\Delta\eta X \Delta\varphi = 0.1X0.1$ (3^{rd} EM layer 0.05X0.05)

Upgrade of Calorimeter Readout



55k readout channels

Two readout paths one for fast trigger and the other for precision readings

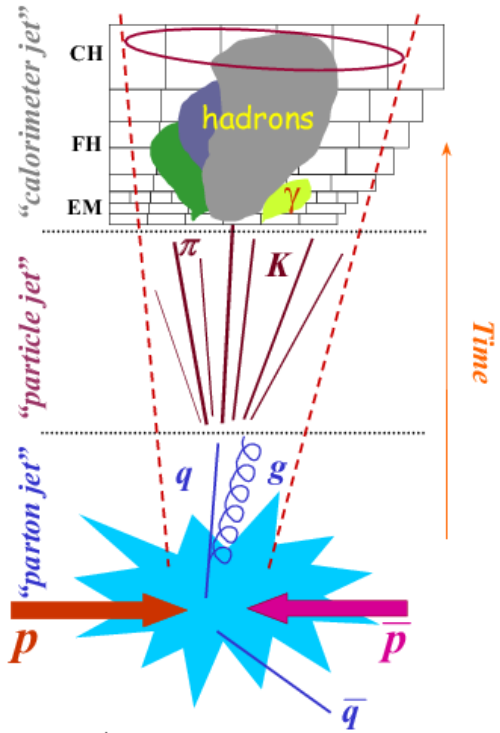
Jet Algorithms

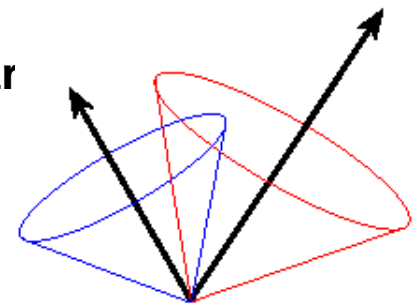
Cone Algorithm in Run I (1992-1995)

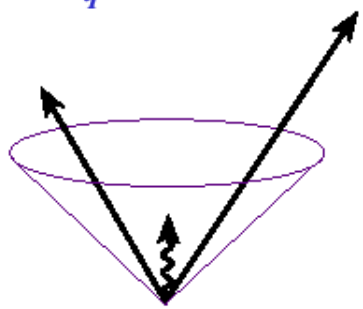
- **Draw a cone of fixed size around a seed.**
- **Compute jet axis by E_T weighted mean and jet E_T by summing over E_T s.**
- **Draw new cone around the new jet axis and recalculate axis and new E_T.**
- **Iterate until stable.**
- **Sensitive to soft radiation.**

Improvements in Run II (2000 -)

- **Use 4 vector scheme instead of E_T**
- **Add midpoints of jets as additional star seeds.**
- **Infrared safe**



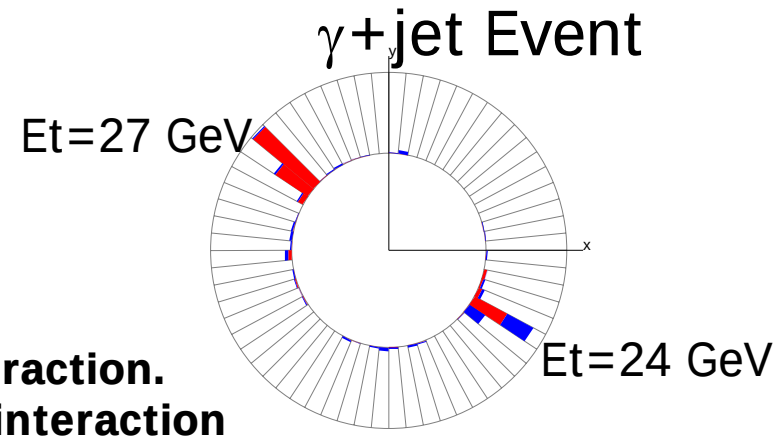




Jet energy Scale

Correction of the jet energy measured at the detector level to the jet energy at the particle level

$$E_{ptcl}^{jet} = \frac{E_{det}^{jet} - \mathcal{O}}{R_{jet}\, S}$$



Offset, O:

Energy that is not associated with the hard interaction. Namely uranium noise, pile-up effect, multiple interaction etc.

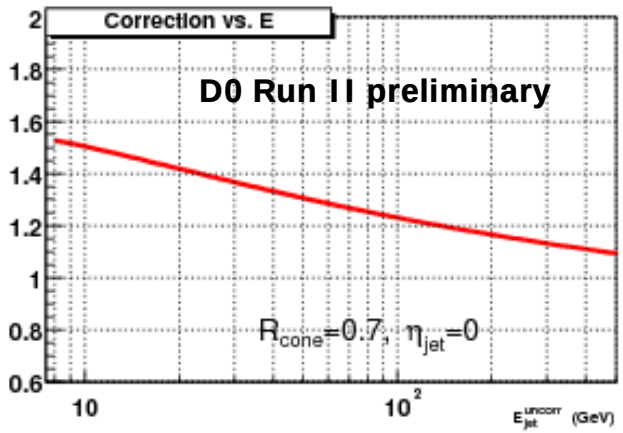
Response, R_{jet}:

Calorimeter energy response to jets, typically <1

Measured by attributing energy imbalance in γ+jet events.

Showering fraction S :

Fraction of the jet energy that showered inside the cone. Depends on cone size.

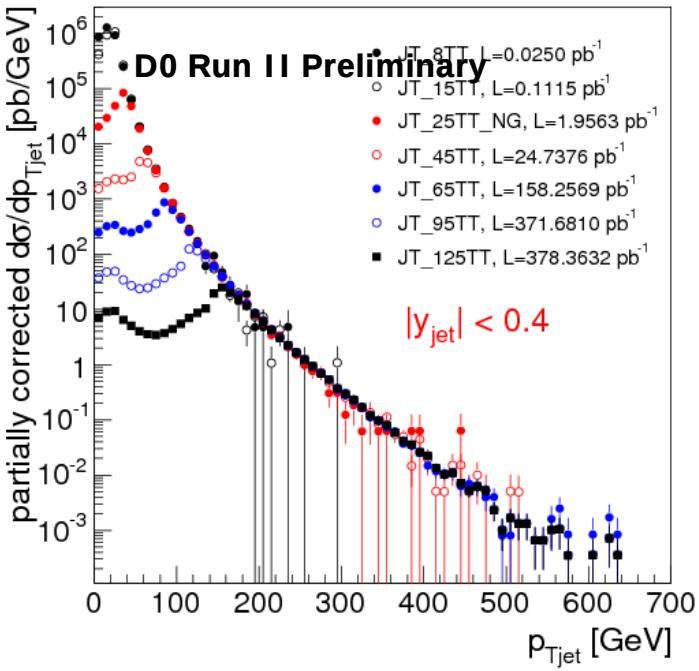


Energy of Jet

Jet triggers and data selection

Data collected during Apr 2002 and Aug 2004 is used.

Total luminosity is 378 pb^{-1} and sqrt s = 1.96 TeV



Triggers

Level 1:

- **Triggering on Calorimeter towers.**
- **Fast trigger readout**
- **multi tower trigger**

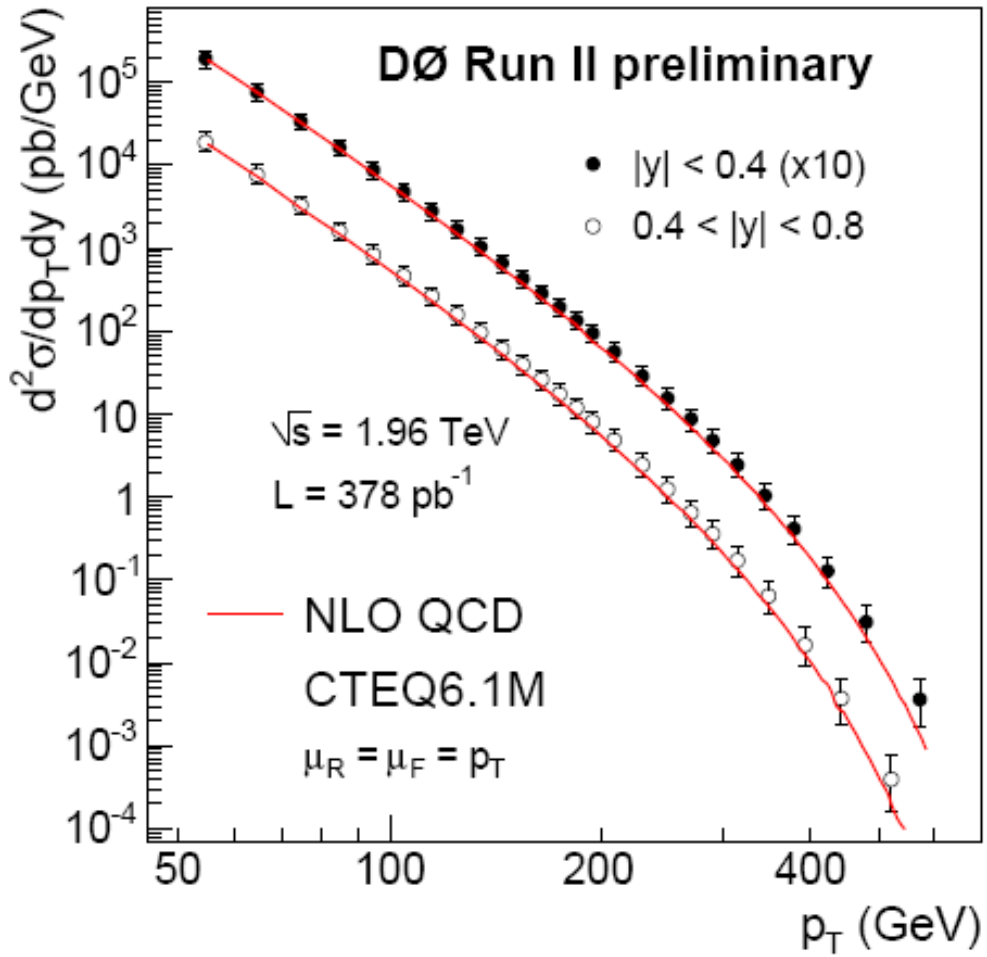
Level 2:

- **Software running on special hardware**
- **3 X 3 or 5X5 square jets**

Level 3:

Runs simple and fast jet algorithm on the precision readout

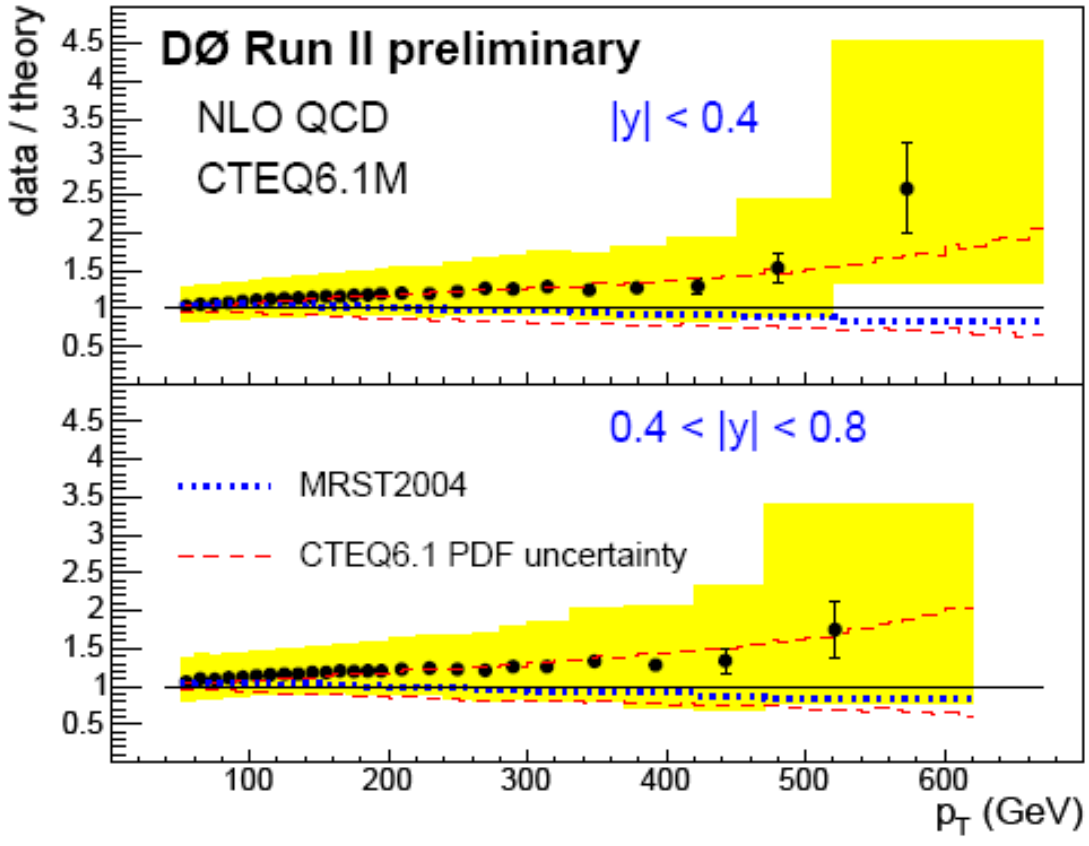
Inclusive jet cross section



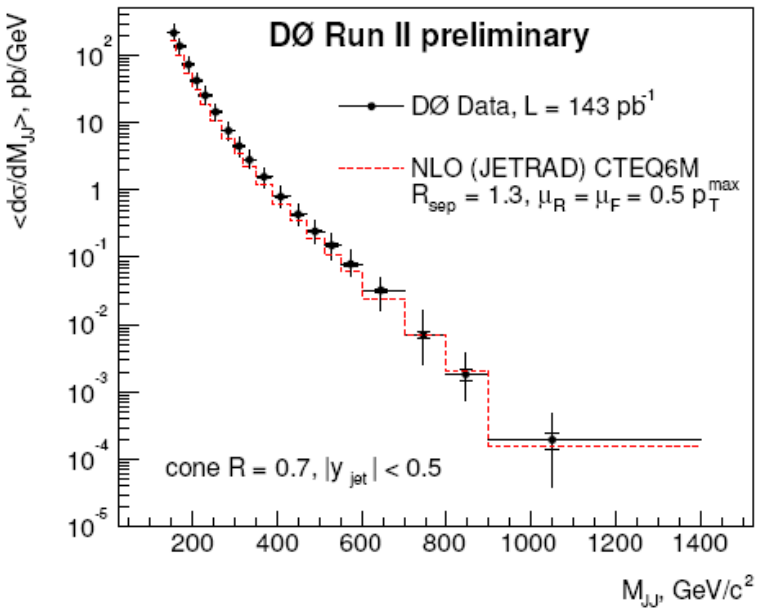
Good agreement with QCD for 8 order of magnitude.

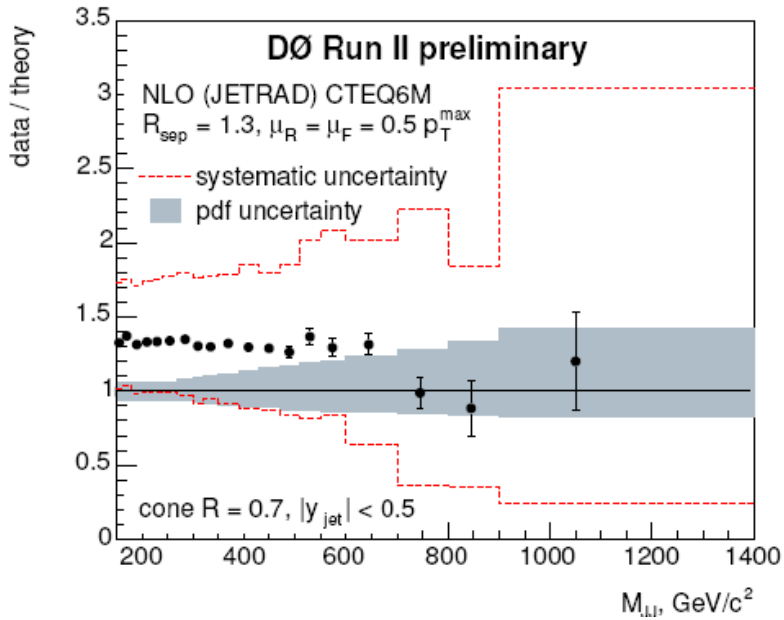
Dominant source of uncertainty is JES

Comparison with NLO QCD



Dijet Cross Section



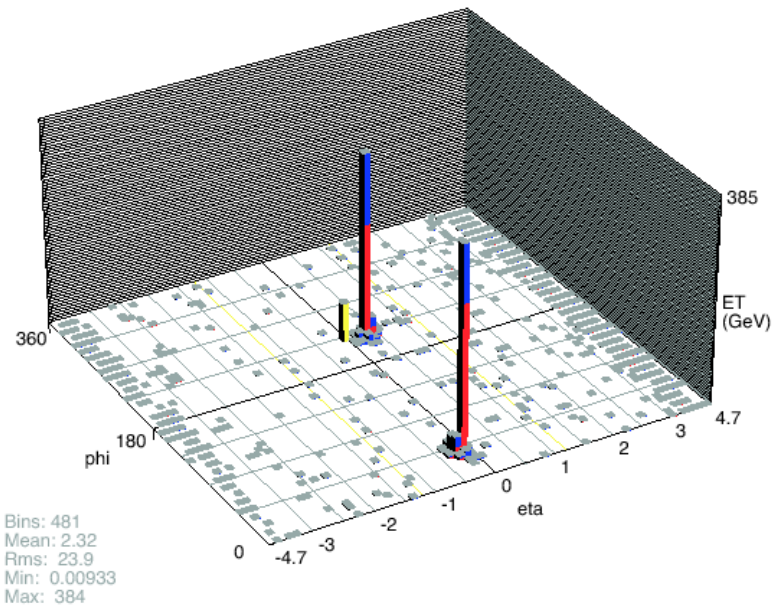


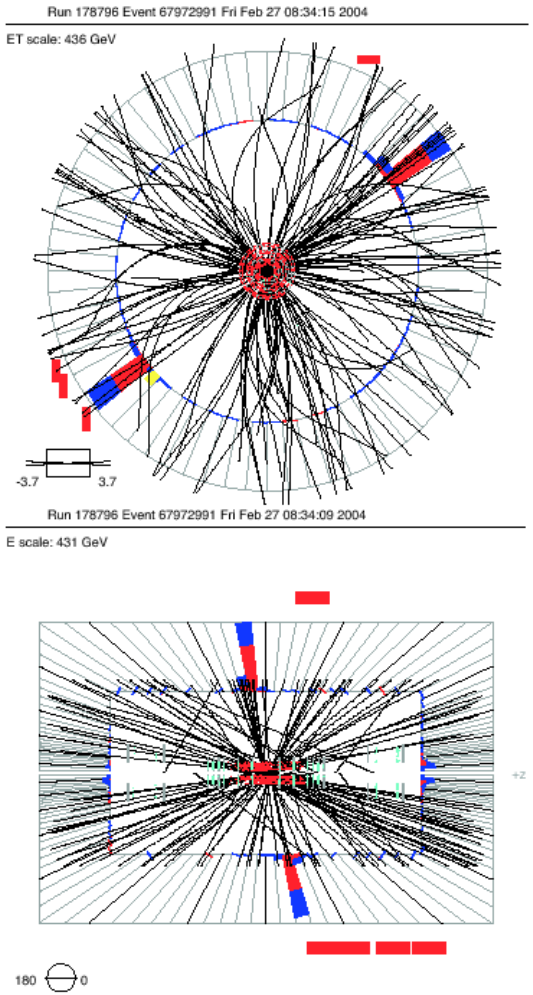
- **NLO QCD is in good agreement with Data**
- **Theoretical uncertainty at high p_T is dominated by knowledge of gluon density**

Highest Pt event

jet 1	jet 2
$p_T = 616\,\mathrm{GeV}$	$p_T = 557\,\mathrm{GeV}$
$y = -0.19$	$y = 0.25$
$\phi = 0.65$	$\phi = 3.78$
$M_{jj} = 1206\,\mathrm{GeV}$	

Run 178796 Event 67972991 Fri Feb 27 08:34:03 2004





Summary

- We have presented preliminary results on inclusive jets and dijets cross-section using data exceeding that of Run I.
  - Larger kinematic ranges are explored
  - With enhanced experimental uncertainty we hope to better understand gluon content at larger x
  - So far measurement is in good agreement with NLO QCD prediction

- **Tevatron is delivering more data.**
- **Huge progress is being made to improve Jet Energy Scale**
- **More precise spectrum with enhanced kinematic reach is coming soon**